Cosmology with BOSS and DES

Erin Sheldon
Brookhaven National Laboratory

My Projects

- Dark Energy Survey (DES), co-leading development of lensing pipelines and analysis codes to measure Dark Energy. Zhoaming Ma has joined us working on testing and development.

- Baryon Oscillation Spectroscopic Survey (BOSS), leading the spectroscopic target selection. Primary goal measurement of Dark Energy properties. Zhaoming analysis.

- Working on early development of Large Synoptic Survey Telescope (LSST) lensing pipelines

DES: Cerro Tololo International Observatory, Chile

Blanco Telescope

Image: David Walker

Dark Energy Survey

- Optical survey of 5000 square degrees in multiple bandpasses.
- 4 meter "Blanco" telescope at Cerro Tololo Inter-American Observatory, Chile.
- First light 2011, running 5 years
- Measure equation of state parameter to 3% using a variety of techniques
- Camera and Telescope upgrades DOE funded

Effects of Dark Energy

- At early times is unimportant to the expansion rate and growth of massive structures
- At late times accelerates the expansion rate, dramatically increasing volume
- Decreases the overall "growth rate" of massive structures.
- Number density of massive structures is decreased relative to equivalent matter only universe

Clusters of Galaxies

Coma Cluster
SDSS Imaging

1.3 Mpc across
1pc = 3.3 lyr

Number Density of Galaxy Clusters

- In the early universe clusters form normally
- At late times Dark Energy accelerates the expansion, reducing the number density relative to a matter-only universe
- Number density of clusters with given mass is sensitive to Dark Energy

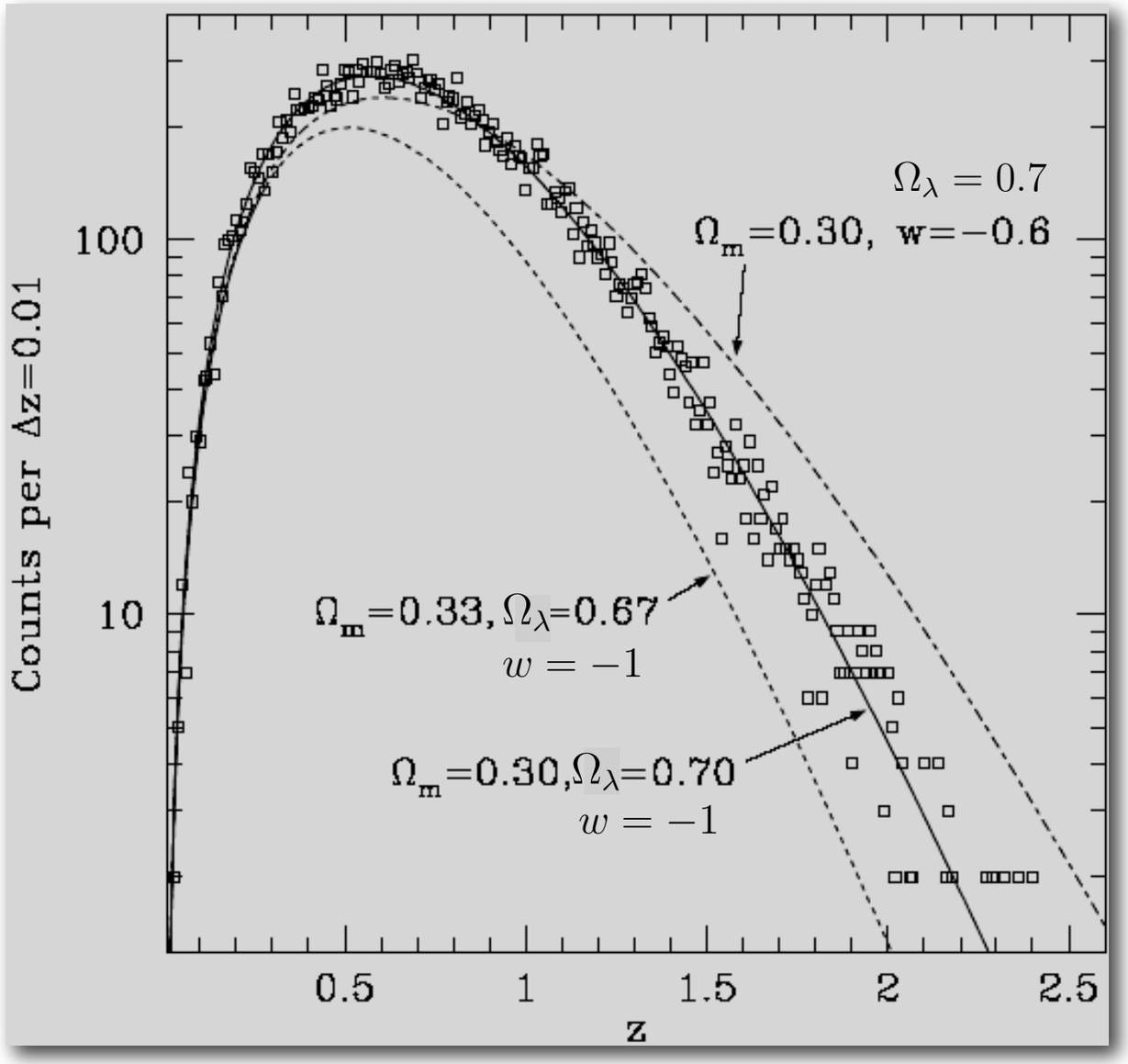
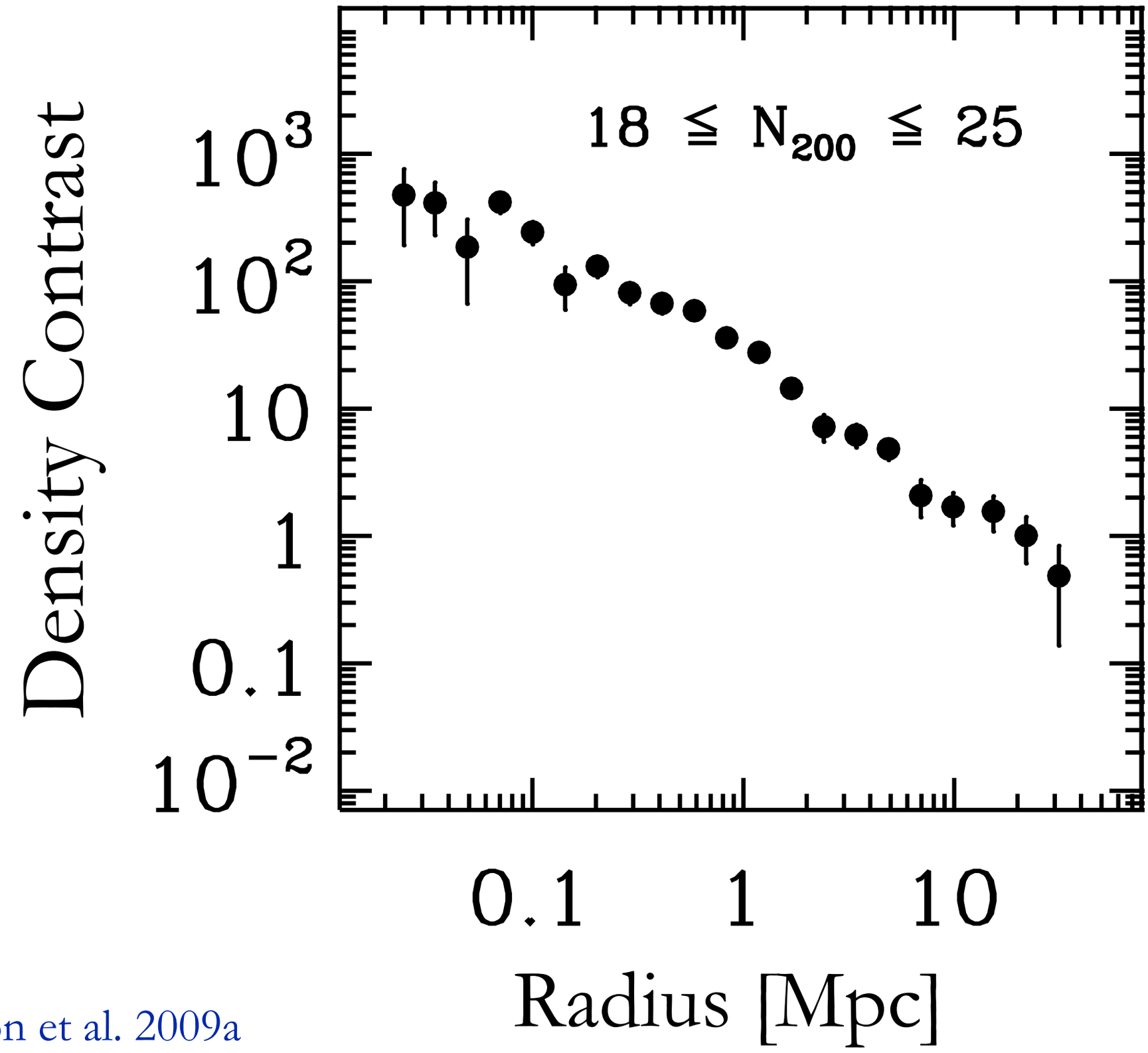


Image Courtesy SPT

Gravitational Lensing

Abell 1689
Hubble Space Telescope

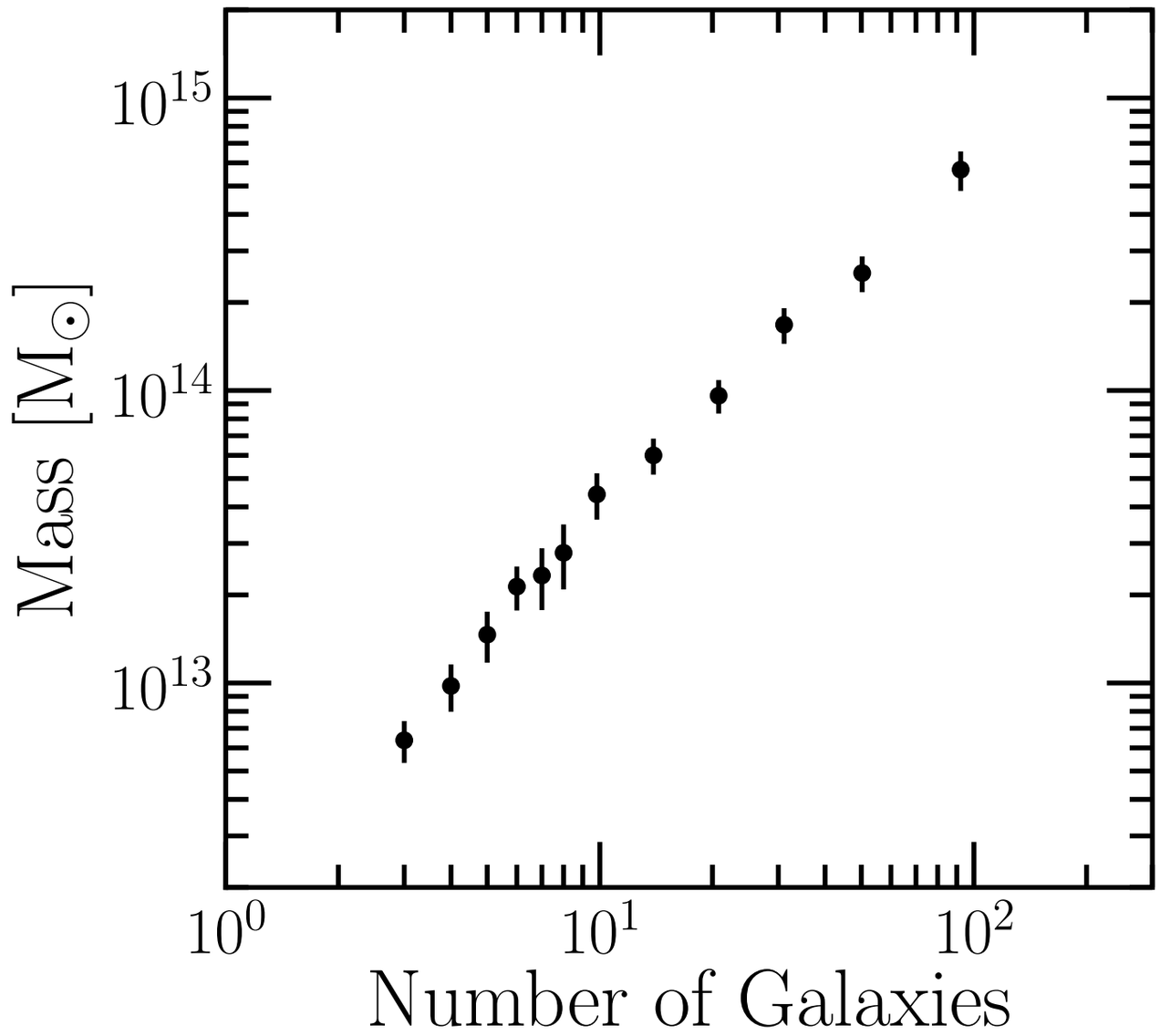


Sheldon et al. 2009a

1pc = 3.26 lyr

SDSS Cluster Lensing

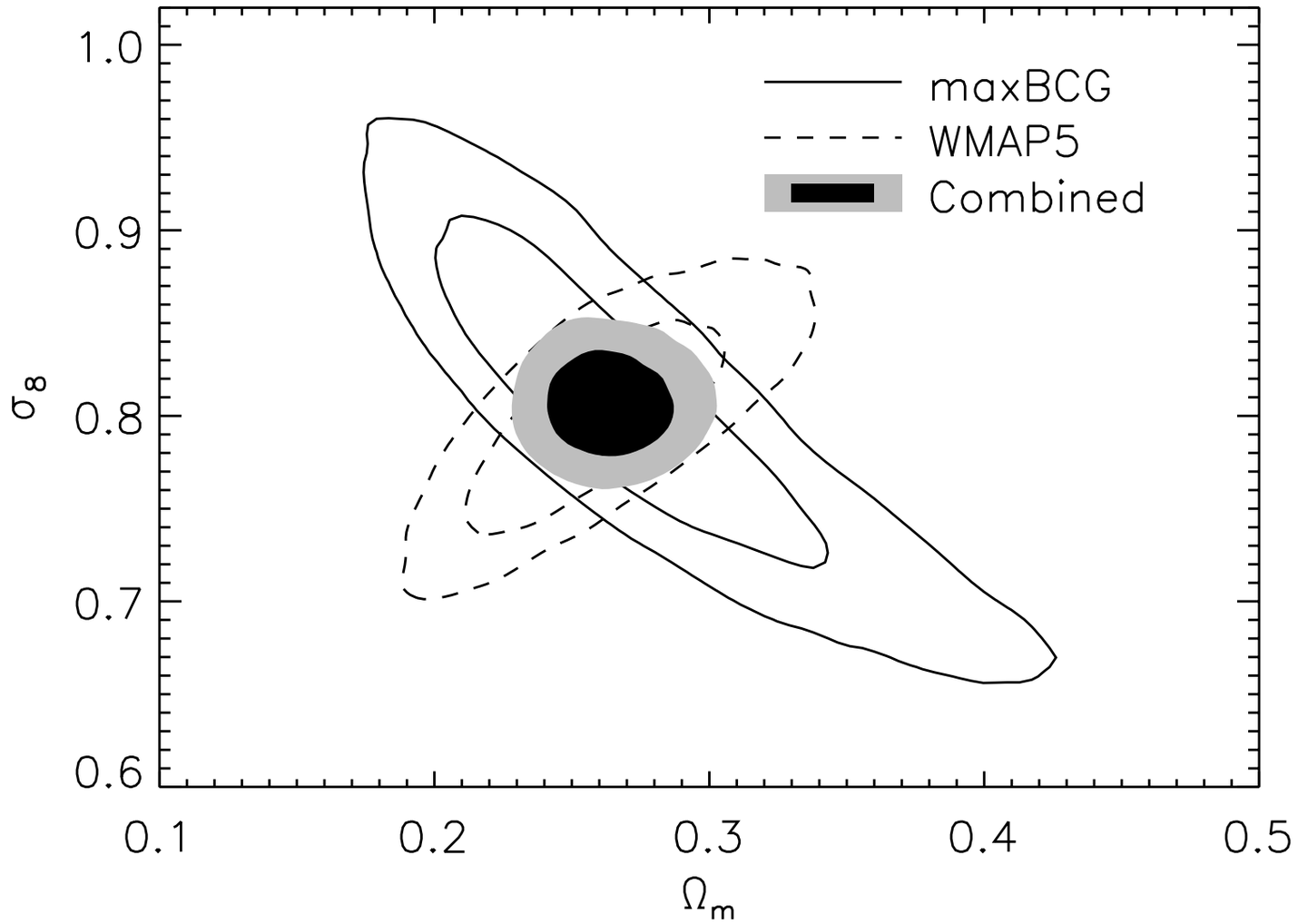
Using existing analysis techniques we can measure the relationship between cluster observables and the total mass



Johnston et al., arXiv:0709.1159

SDSS Cluster Lensing

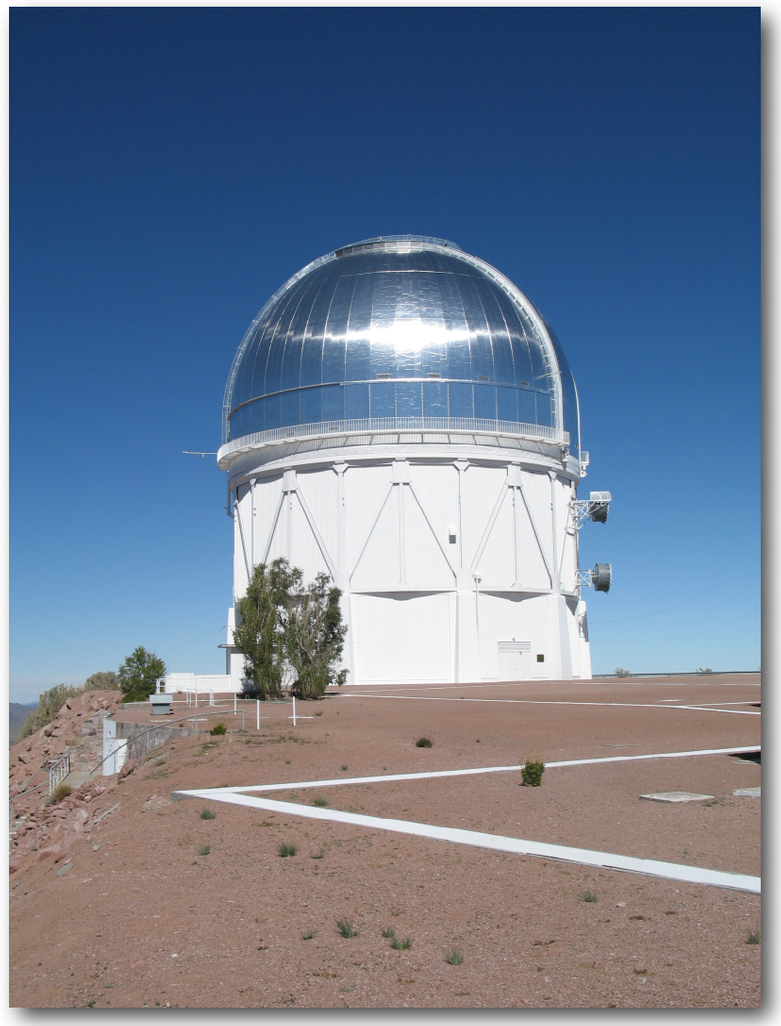
Once the masses are known, tight constraints on cosmological parameters can be derived



Rozo, et al. 2010

Dark Energy Survey

- We can apply the same analysis in tens of equal volume samples through time
- Combining just lensing probes, constrains w to 3% statistical.
- Use supernovae and priors from other experiments (Planck) to break degeneracies
- Techniques used in the DES will translate naturally to LSST



4m Blanco Telescope
Image: David Walker

BOSS Target Selection

- I am in charge of target selection
- BAO feature:
  - Imprinted on the spatial distribution of galaxies (LRGs)
  - Imprinted on the spatial distribution of Gas: LyA Forest (QSOs)
- We must select these objects from the imaging for spectroscopic follow-up.

BOSS Target Selection

- I developed the software framework for target selection
- Incorporated LRG selection (w/Padmanabhan) and various QSO selection methods (w/many others).
- LRGs: straightforward color selection.
- QSOs: Difficult, selecting targets has required significant advancement in this field (~1 thesis)
- Performed testing of algorithms. Tuned selections to proper densities and to maximize efficiency and scientific return.

BOSS Data

- Targets were delivered on time for commissioning last fall.
- We have since begun the “main” survey.
- LRG sample is comparable to existing samples.
- QSO sample is already larger than all existing samples in this difficult redshift range.

My Plans with BOSS

- BOSS is a continuation of the SDSS
- Perform lensing analyses of Galaxy Clusters on ~twice as much data as previous SDSS analysis. Sensitive to cosmological parameters.
- Lensing analysis of new LRG sample
- Analyze deeper coadd data using DES pipeline. Study "cosmic shear". Combined analysis with CMB will be sensitive to dark energy
- Data is multi-epoch: Direct test of DES pipelines.

Extra Slides

Computing Proposal

- The DES Weak Lensing Working Group has submitted a proposal for computing support.
- Primarily for WL image processing, secondarily for analysis.
- $50,000 per year for five years: CPU (70 nodes) and Disk (~200 TB).
- BNL will host at the Brookhaven Computing Facility
- 40% bulk discounts, free power, cooling, and infrastructure support.